



Meteorological Conditions Experienced During the Orion Pad Abort Test

***Edward H. Teets Jr.
NASA Dryden Flight Research Center***

***Range Commanders Council, Meteorology Group Annual Meeting
May 10-12, 2011
Satellite Beach, FL***



Contributors



PA-1 Flight Dynamics
Lockheed Martin

Brian Clarke
William Pratt



Contributors



White Sands Missile Range Weather

Scott Startz

Joshua Schroeder

Mickey Rupe

Anna Phelps

James Wilkes

Edward Ellison

Larry Misquez



Agenda



- **Test Objectives**
- **Terrain Features**
- **Test Configuration**
 - **Range Assets**
- **Weather Brief**
 - **Forecasts**
 - **Day of Launch Observations**
- **Summary**



Flight Test Objectives Overview



Primary Test Objectives

- **Performance of the Launch Abort System (LAS)**
- **Stability and control characteristics of a crew module in regards to the LAS**
- **Determine the performance of the abort, jettison and attitude control motors**
- **Demonstrate abort event sequencing from abort initiation through LAS jettison**
- **Obtain LAS/crew module interface structural loads and external acoustics data**

Secondary Test Objectives

- **Parachute assembly system event sequencing**
- **Performance of the main parachute system.**



Natural Terrain - Organ Mountains





Terrain View from LC-32E



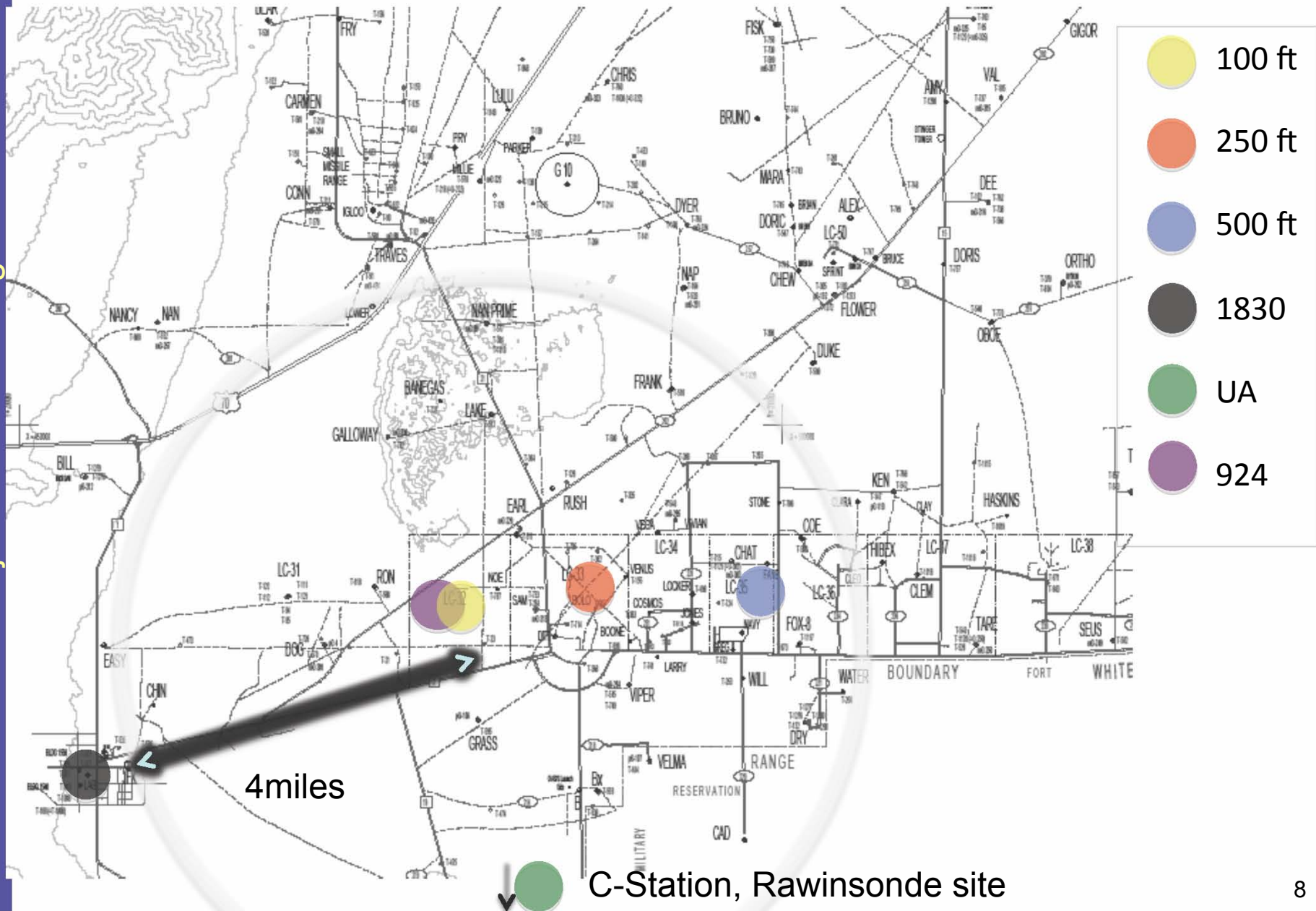
Organ Mountains: View from LC-32E





Test Configuration - Range

Weather assets





924 MHz Profiler





SAMS Wind Tower at LC-32E

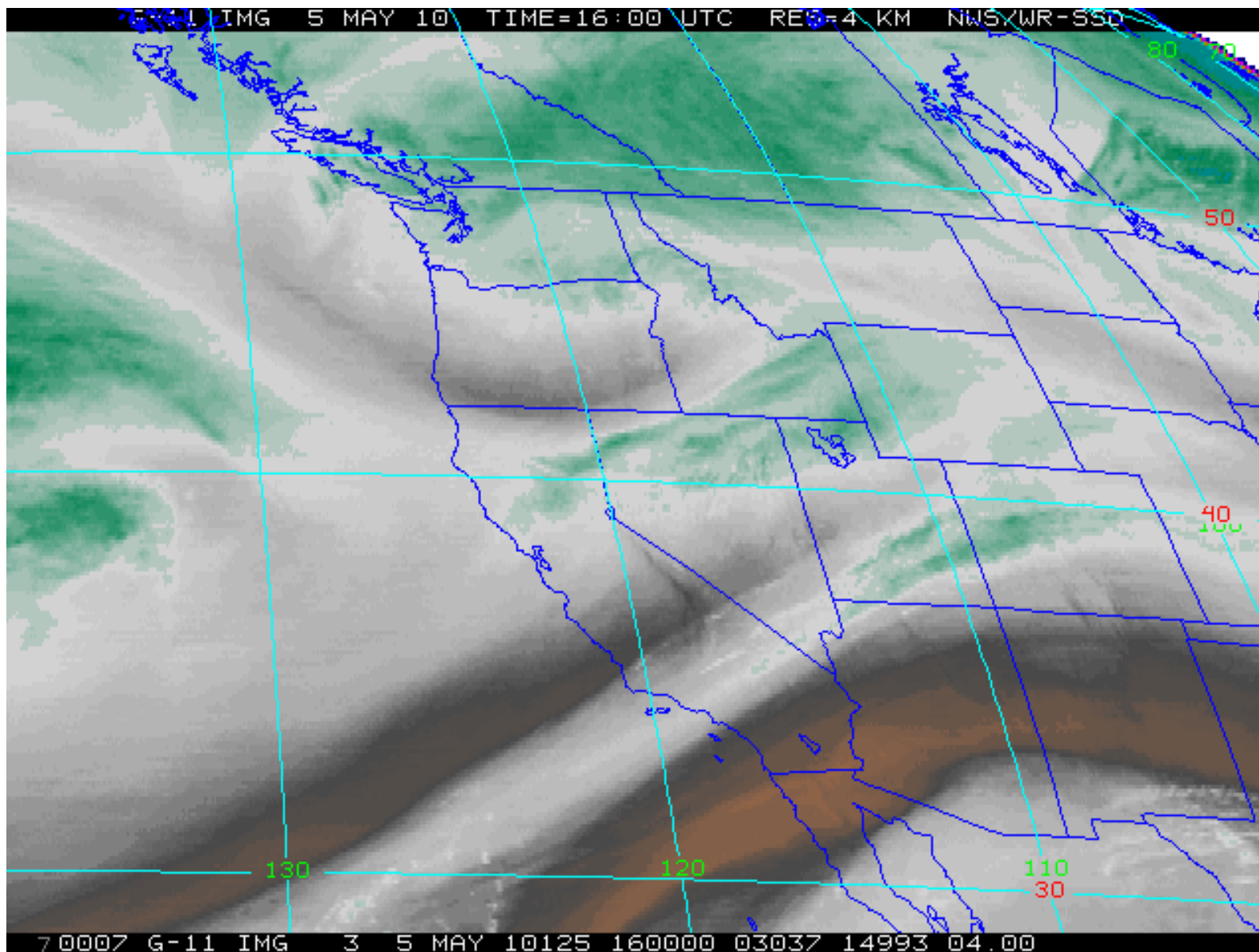




Day of Launch Forecast

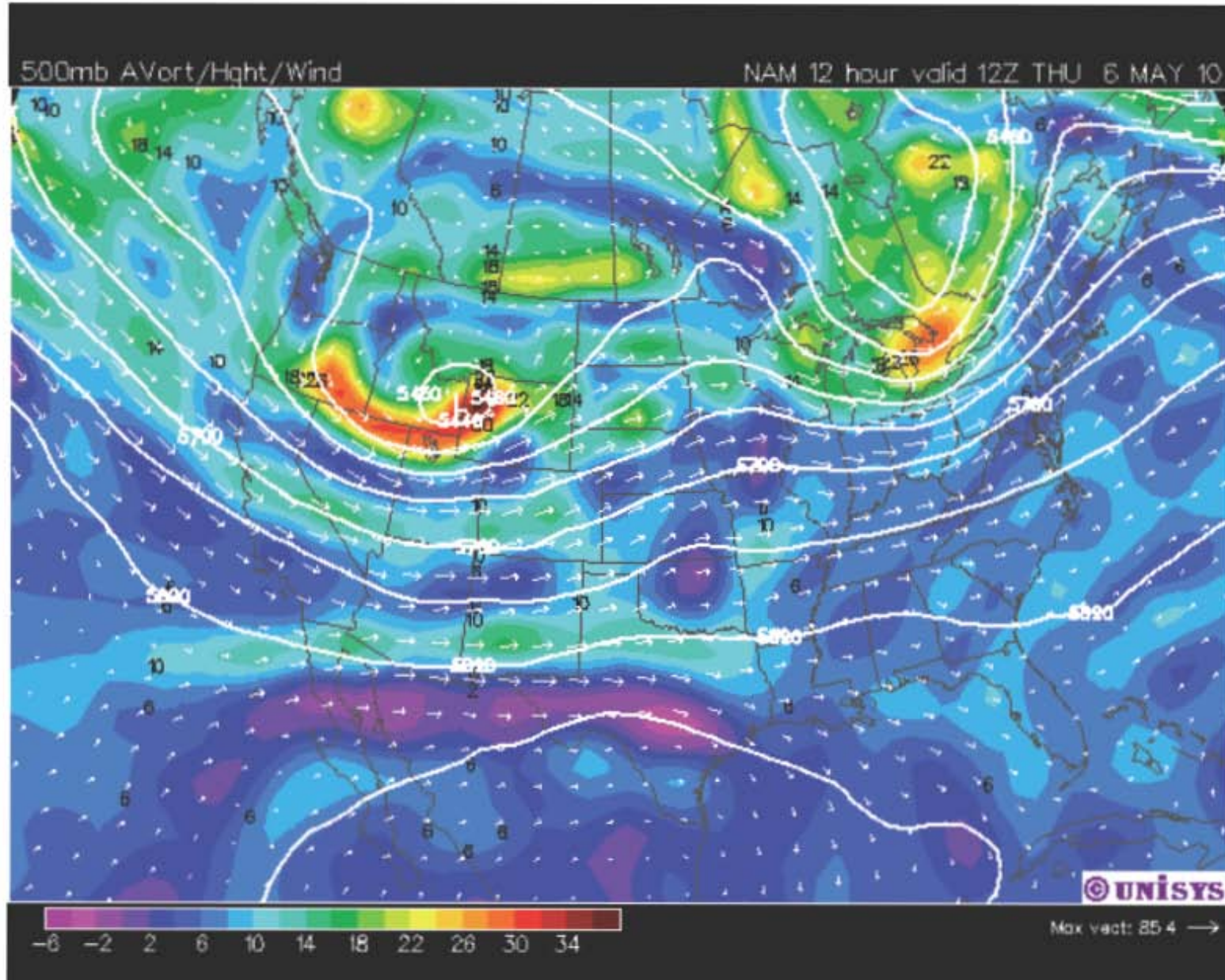


WV Satellite Data for Western US





Upper Air Forecast for DOL





T-1 Day Forecast



WGS-34 Ellipsoid
(ft)
Project Orion Abort Flight Test

Project Orion Abort Flight Test

WGS-84 Ellipsoid (ft)

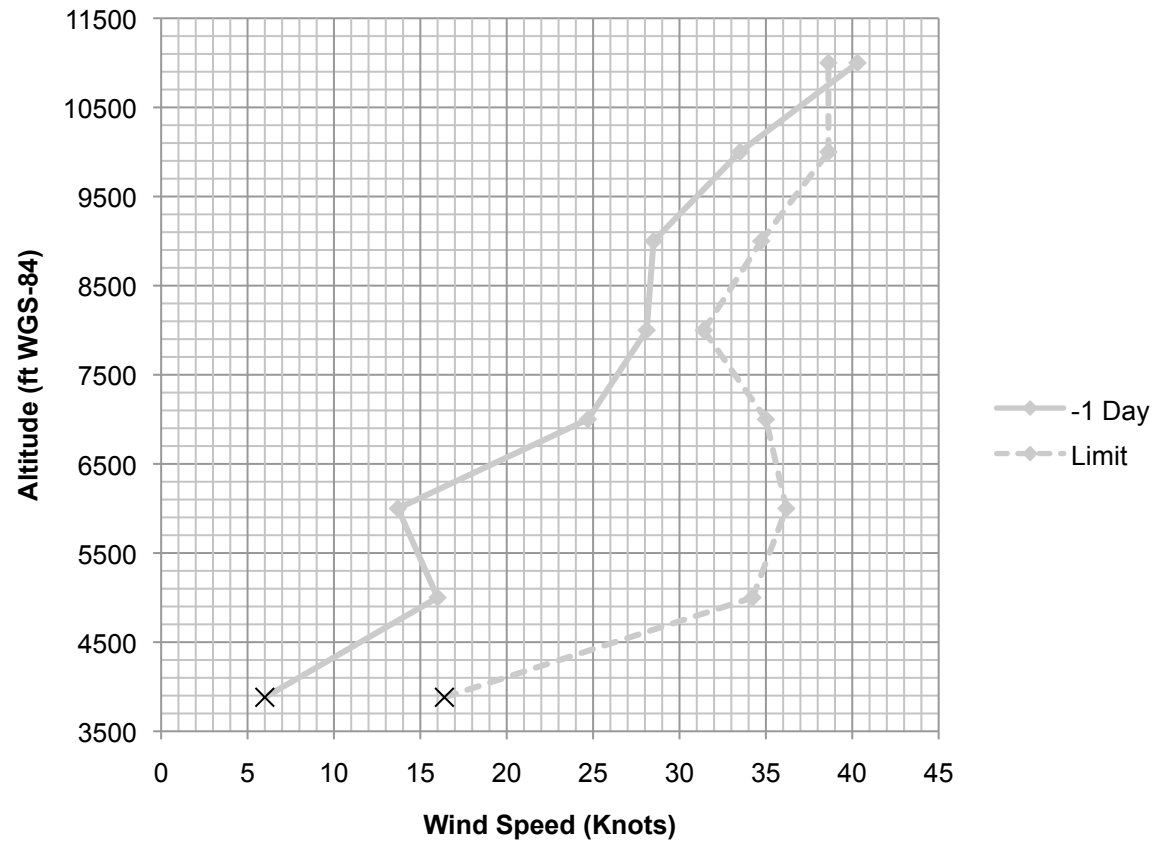
		Time of Forecast (T- time)		-1 Day																	
		T-0 Forecast Winds		Comparison		Flight Wind Limits															
		Balloon & LC-32E Data Entry		Difference (Balloon - Limit)		Wind Speeds in Knots		Azimuth Clockwise from 0° North (degrees)													
								Meteorological Convention													
								(Azimuth Defines Direction Wind is Blowing From)													
		Azimuth (Meterological degrees)	Wind Speed (knots)	(knots)	(percent)			1-30	31-60	61-90	91-120	121-150	151-180	181-210	211-240	241-270	271-300	301-330	331-360		
	Ground Level*	190	6	-10.4	-63.4%	Altitude Above WGS-84 Ellipsoid	Ground Level*	17.0	19.0	17.4	14.8	11.6	13.3	16.4	24.2	23.9	16.3	13.6	13.3		
	5000	267	16	-18.2	-53.3%		5000	20.2	21.6	18.2	17.2	17.8	18.4	25.8	30.5	34.2	20.7	20.0	19.2		
	6000	257	13.7	-22.5	-62.1%		6000	20.8	23.8	20.5	17.9	18.4	18.5	26.5	33.3	36.2	28.3	21.4	23.3		
	7000	271	24.7	-10.3	-29.4%		7000	24.6	26.1	23.1	18.1	17.6	17.1	27.1	35.2	41.6	35.0	24.6	27.7		
	8000	269	28.1	-3.3	-10.5%		8000	19.7	17.5	14.8	17.6	17.2	16.8	20.2	28.1	31.4	25.0	19.5	19.8		
	9000	263	28.5	-6.2	-17.9%		9000	22.6	17.9	15.7	16.5	16.4	16.3	20.3	31.7	34.7	28.7	22.0	23.2		
	10000	263	33.5	-5.1	-13.3%		10000	23.2	18.1	17.4	17.2	17.6	18.1	21.7	33.4	38.6	32.7	25.9	26.8		
	11000	257	40.3	1.7	4.4%		11000	23.2	18.1	17.4	17.2	17.6	18.1	21.7	33.4	38.6	32.7	25.9	26.8		
										</											



T-1 Day Forecast



T-0 Forecast Wind Speeds vs Altitude





T-1 Day + 2 hrs Forecast



WGS-84 Ellipsoid
Project Orion Abort Flight Test
(ft)

WGS-84 Ellipsoid Project Orion Abort Flight Test

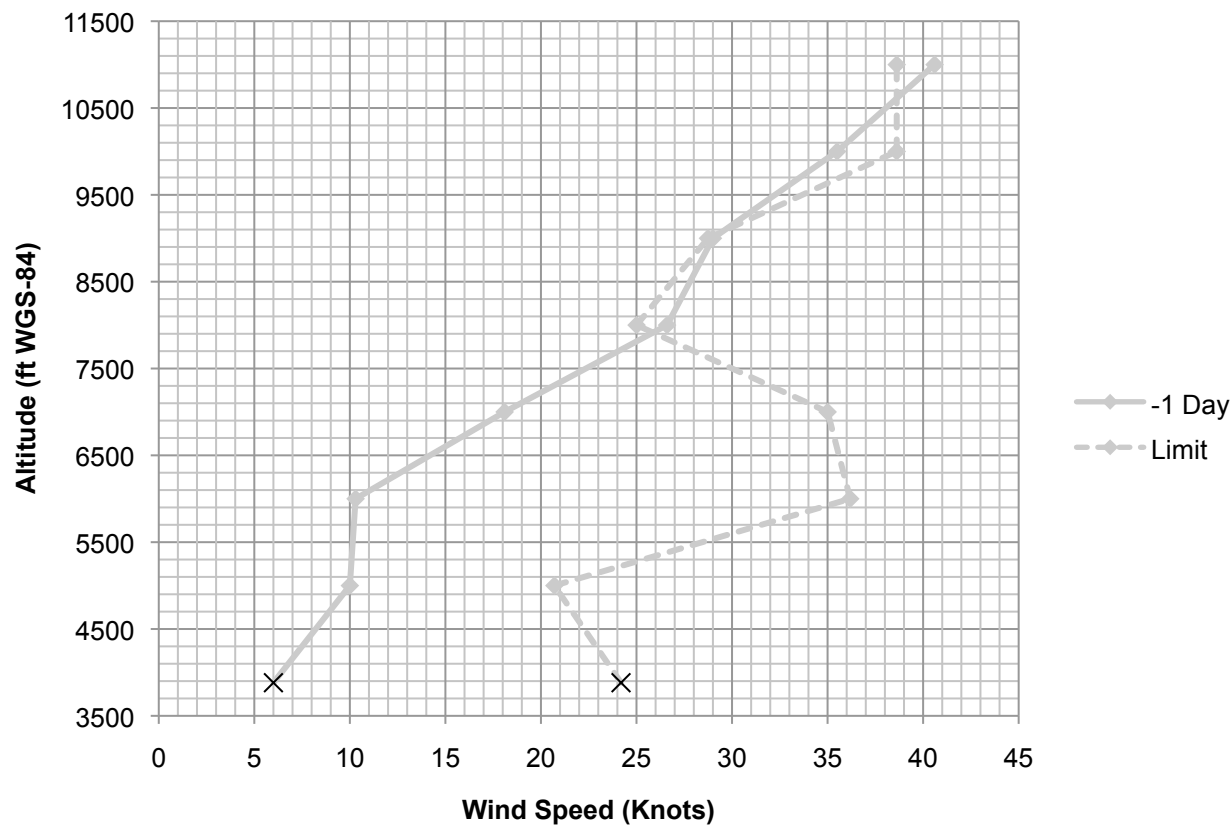
Time of Forecast (T- time)		-1 day																																					
T+2 Forecast Winds				Comparison		Flight Wind Limits																																	
Balloon & LC-32E Data Entry				Difference (Balloon - Limit)		Wind Speeds in Knots		Azimuth Clockwise from 0° North (degrees)																															
								<u>Meteorological Convention</u>																															
								(Azimuth Defines Direction Wind is <u>Blowing From</u>)																															
Azimuth (Meterological degrees)		Wind Speed (knots)		(knots)	(percent)			1-30	31-60	61-90	91-120	121-150	151-180	181-210	211-240	241-270	271-300	301-330	331-360																				
Ground Level*	226	6	-18.2	-75.2%	Altitude Above WGS-84 Ellipsoid (ft)	Ground Level*	17.0	19.0	17.4	14.8	11.6	13.3	16.4	24.2	23.9	16.3	13.6	13.3																					
5000	277	10	-10.7	-51.7%		5000	20.2	21.6	18.2	17.2	17.8	18.4	25.8	30.5	34.2	20.7	20.0	19.2																					
6000	262	10.3	-25.9	-71.5%		6000	20.8	23.8	20.5	17.9	18.4	18.5	26.5	33.3	36.2	28.3	21.4	23.3																					
7000	272	18.1	-16.9	-48.3%		7000	24.6	26.1	23.1	18.1	17.6	17.1	27.1	35.2	41.6	35.0	24.6	27.7																					
8000	278	26.6	1.6	6.4%		8000	19.7	17.5	14.8	17.6	17.2	16.8	20.2	28.1	31.4	25.0	19.5	19.8																					
9000	273	29	0.3	0.9%		9000	22.6	17.9	15.7	16.5	16.4	16.3	20.3	31.7	34.7	28.7	22.0	23.2																					
10000	266	35.5	-3.1	-8.1%		10000	23.2	18.1	17.4	17.2	17.6	18.1	21.7	33.4	38.6	32.7	25.9	26.8																					
11000	258	40.6	2.0	5.1%		11000	23.2	18.1	17.4	17.2	17.6	18.1	21.7	33.4	38.6	32.7	25.9	26.8																					
				-71.0																																			
*Ground Level refers to LC-32 ground level wind measurement @ 3881.56 ft above WGS-84. This line should be compared to ground level wind measurements at LC-32 (6 ft AGL), not balloon data.																																							
<div>Key for Comparison Table</div> <div>Violate Limits</div> <div>Meet Limits (<10% Margin)</div> <div>Meet Limits (>10% Margin)</div>																				<div>Key for Flight Wind Limits Table</div> <div>Violate Limits</div> <div>Meet Limits</div>																			



T-1 Day + 2 hrs Forecast



T+02:00:00 Forecast Wind Speeds vs Altitude



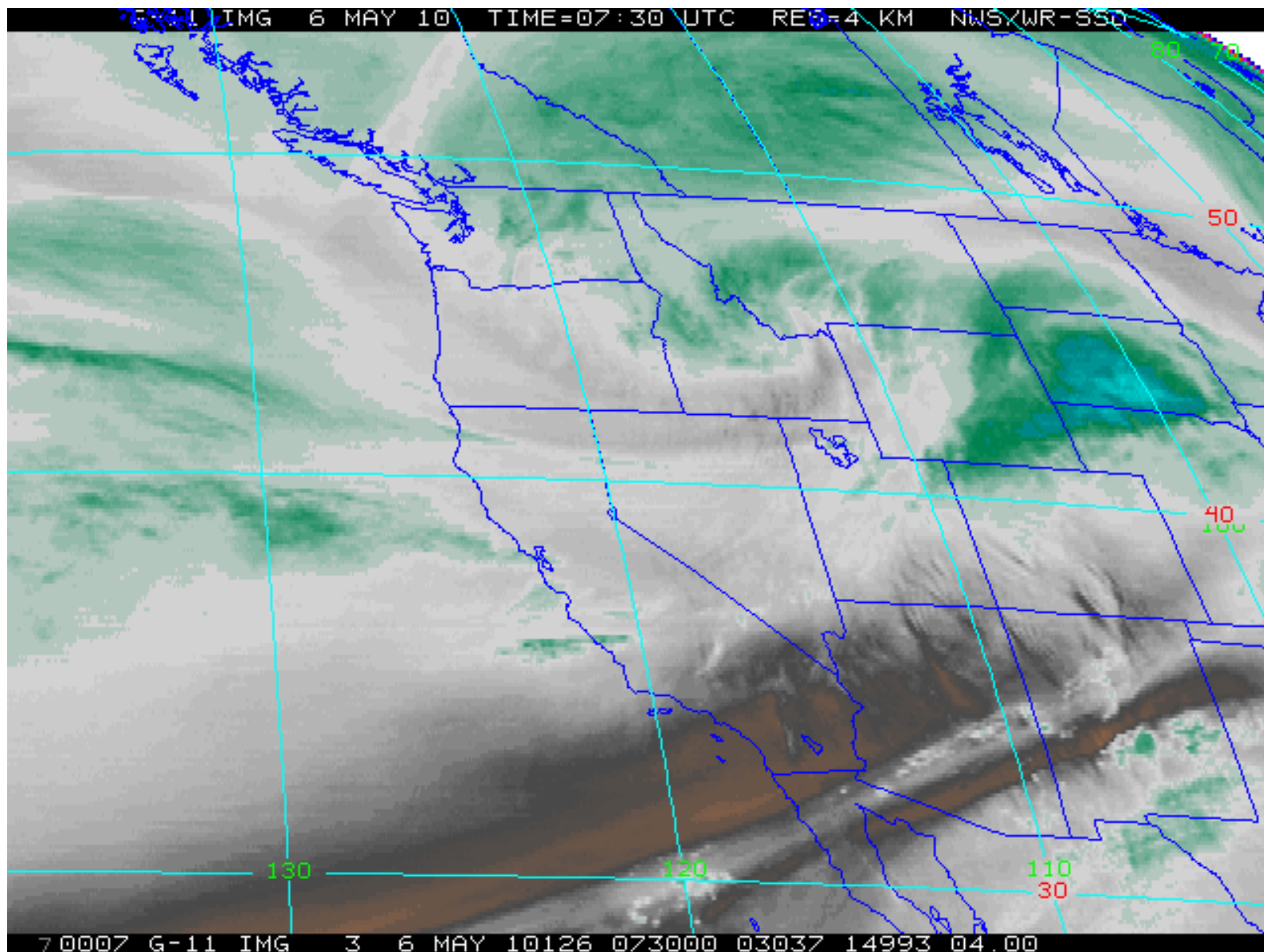


Day of Launch Weather

May 6, 2011

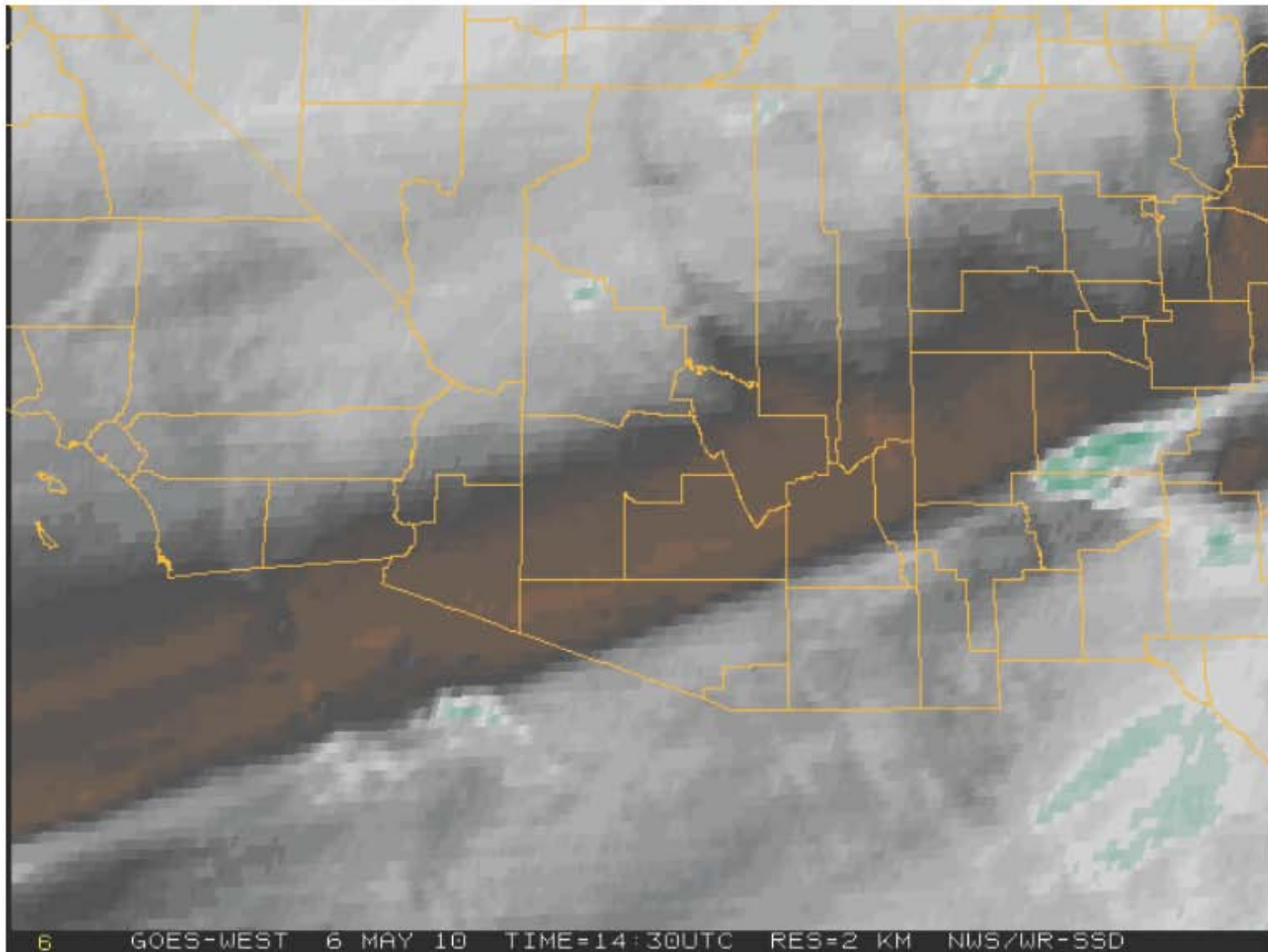


WV Satellite Data for Western US



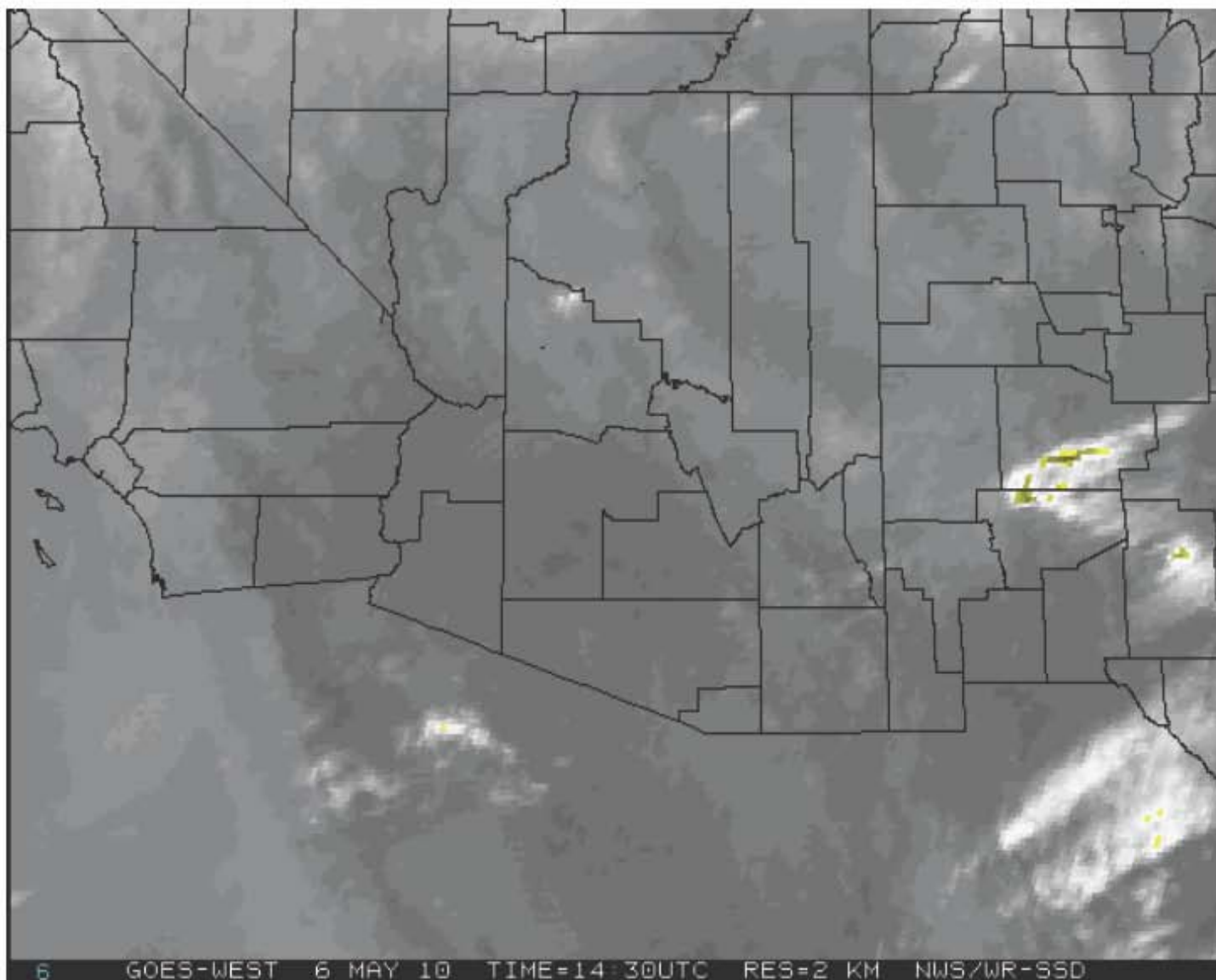


WV Satellite View





IR Satellite View





Day of Launch Weather



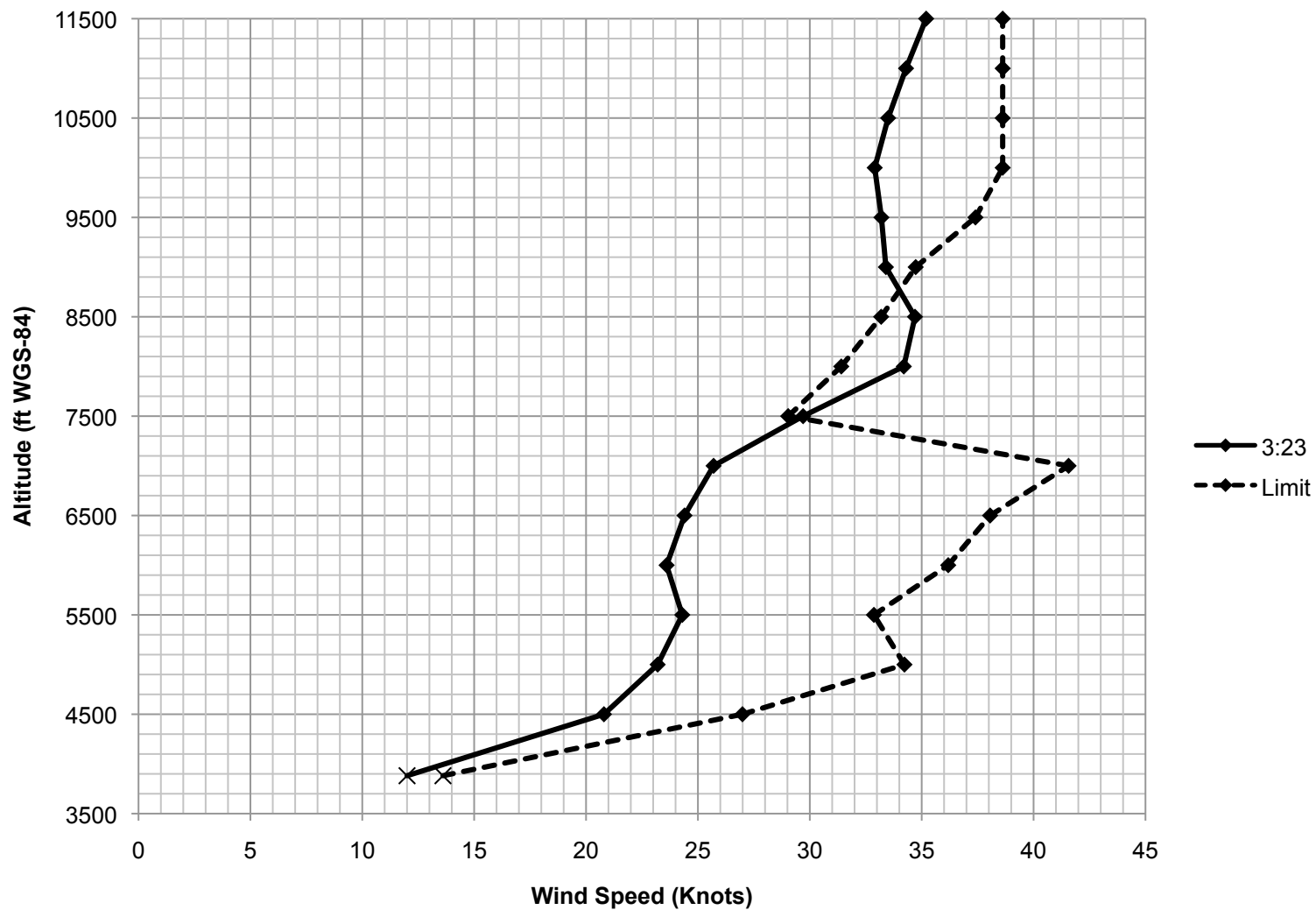
T-3:15 hrs Balloon (0945Z)

st

		Balloon Launch Local Time		3:23															
		Measured Winds		Comparison		Flight Wind Limits													
		Balloon & LC-32E Data Entry		Difference (Balloon - Limit)		Wind Speeds in Knots	Azimuth Clockwise from 0° North (degrees) <u>Meteorological Convention</u> (Azimuth Defines Direction Wind is <u>Blowing From</u>)												
		Azimuth (Meterological degrees)	Wind Speed (knots)	(knots)	(percent)		1-30	31-60	61-90	91-120	121-150	151-180	181-210	211-240	241-270	271-300	301-330	331-360	
Altitude Above WGS-84 Ellipsoid (ft)	Ground Level*	310	12	-1.6	-11.8%	Altitude Above WGS-84 Ellipsoid (ft)	Ground Level*	17.0	19.0	17.4	14.8	11.6	13.3	16.4	24.2	23.9	16.3	13.6	13.3
	4500	267	20.8	-6.2	-22.9%		4500	16.2	18.9	18.1	14.8	14.9	16.0	21.4	29.8	27.0	18.1	18.2	17.2
	5000	254	23.2	-11.0	-32.2%		5000	20.2	21.6	18.2	17.2	17.8	18.4	25.8	30.5	34.2	20.7	20.0	19.2
	5500	254	24.3	-8.6	-26.1%		5500	21.4	22.7	18.2	16.6	16.5	21.9	25.4	30.8	32.9	23.9	20.1	20.6
	6000	258	23.6	-12.6	-34.8%		6000	20.8	23.8	20.5	17.9	18.4	18.5	26.5	33.3	36.2	28.3	21.4	23.3
	6500	265	24.4	-13.7	-35.9%		6500	23.1	25.7	21.3	18.0	18.4	18.7	27.8	36.2	38.1	28.8	24.5	24.5
	7000	267	25.7	-15.9	-38.2%		7000	24.6	26.1	23.1	18.1	17.6	17.1	27.1	35.2	41.6	35.0	24.6	27.7
	7500	262	29.7	0.7	2.3%		7500	17.9	17.1	14.3	15.7	14.2	15.8	19.1	26.3	29.0	23.0	18.8	18.2
	8000	257	34.2	2.8	8.9%		8000	19.7	17.5	14.8	17.6	17.2	16.8	20.2	28.1	31.4	25.0	19.5	19.8
	8500	252	34.7	1.5	4.6%		8500	21.3	17.2	14.7	17.2	17.1	17.0	20.6	29.9	33.2	27.6	21.0	21.1
	9000	246	33.4	-1.3	-3.8%		9000	22.6	17.9	15.7	16.5	16.4	16.3	20.3	31.7	34.7	28.7	22.0	23.2
	9500	243	33.2	-4.2	-11.2%		9500	23.8	18.4	16.2	15.7	16.4	17.6	21.3	33.6	37.4	30.7	24.0	24.0
	10000	242	32.9	-5.7	-14.8%		10000	23.2	18.1	17.4	17.2	17.6	18.1	21.7	33.4	38.6	32.7	25.9	26.8
	10500	241	33.5	-5.1	-13.3%		10500	23.2	18.1	17.4	17.2	17.6	18.1	21.7	33.4	38.6	32.7	25.9	26.8
11000	242	34.3	-4.3	-11.2%	11000	23.2	18.1	17.4	17.2	17.6	18.1	21.7	33.4	38.6	32.7	25.9	26.8		
11500	248	35.2	-3.4	-8.9%	11500	23.2	18.1	17.4	17.2	17.6	18.1	21.7	33.4	38.6	32.7	25.9	26.8		
				-88.6															
*Ground Level refers to LC-32 ground level wind measurement @ 3881.56 ft above WGS-84. This line should be compared to ground level wind measurements at LC-32 (6 ft AGL), not balloon data.																			
<div><div>Key for Comparison Table</div><div>Violate Limits <div></div></div><div>Meet Limits (<10% Margin) <div></div></div><div>Meet Limits (>10% Margin) <div></div></div></div> <div><div>Key for Flight Wind Limits Table</div><div>Violate Limits <div></div></div><div>Meet Limits <div></div></div></div>																			



Day of Launch Weather





Day of Launch Weather

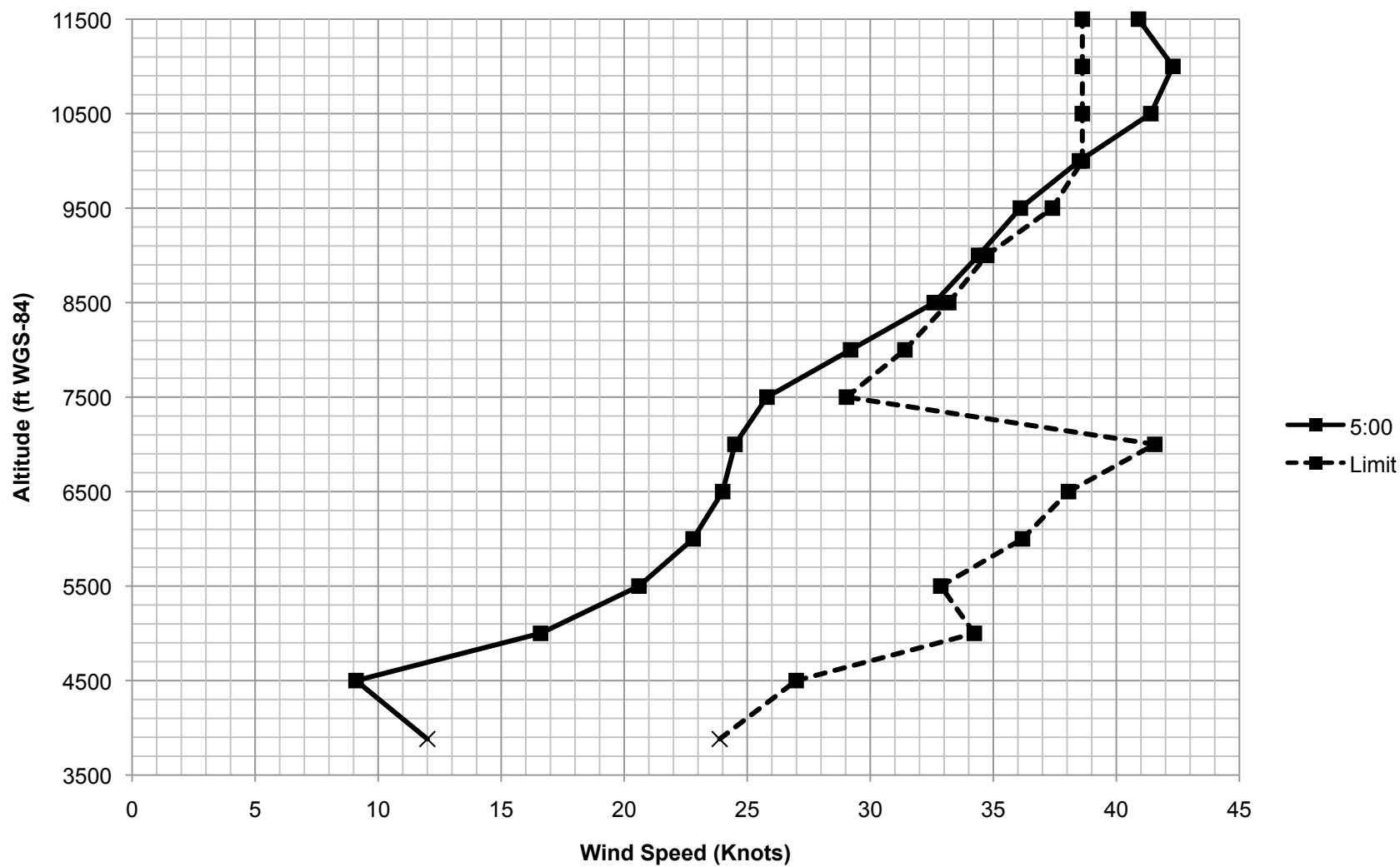


T-2:00 hrs Balloon (1100Z)

		Balloon Launch Local Time		5:00																
		Measured Winds		Comparison		Flight Wind Limits														
		Balloon & LC-32E Data Entry		Difference (Balloon - Limit)		Wind Speeds in Knots		Azimuth Clockwise from 0° North (degrees)												
		Azimuth (Meterological degrees)		Wind Speed (knots)				(knots)		(percent)		<u>Meteorological Convention</u> (Azimuth Defines Direction Wind is <u>Blowing From</u>)								
								1-30	31-60	61-90	91-120	121-150	151-180	181-210	211-240	241-270	271-300	301-330	331-360	
Altitude Above WGS-84 Ellipsoid (ft)	Ground Level†	270	12	-11.9	-49.7%	Altitude Above WGS-84 Ellipsoid (ft)	Ground Level†	17.0	19.0	17.4	14.8	11.6	13.3	16.4	24.2	23.9	16.3	13.6	13.3	
	4500	254	9.1	-17.9	-66.3%		4500	16.2	18.9	18.1	14.8	14.9	16.0	21.4	29.8	27.0	18.1	18.2	17.2	
	5000	267	16.6	-17.6	-51.5%		5000	20.2	21.6	18.2	17.2	17.8	18.4	25.8	30.5	34.2	20.7	20.0	19.2	
	5500	259	20.6	-12.3	-37.3%		5500	21.4	22.7	18.2	16.6	16.5	21.9	25.4	30.8	32.9	23.9	20.1	20.6	
	6000	249	22.8	-13.4	-37.0%		6000	20.8	23.8	20.5	17.9	18.4	18.5	26.5	33.3	36.2	28.3	21.4	23.3	
	6500	253	24	-14.1	-36.9%		6500	23.1	25.7	21.3	18.0	18.4	18.7	27.8	36.2	38.1	28.8	24.5	24.5	
	7000	261	24.5	-17.1	-41.1%		7000	24.6	26.1	23.1	18.1	17.6	17.1	27.1	35.2	41.6	35.0	24.6	27.7	
	7500	268	25.8	-3.2	-11.1%		7500	17.9	17.1	14.3	15.7	14.2	15.8	19.1	26.3	29.0	23.0	18.8	18.2	
	8000	264	29.2	-2.2	-7.0%		8000	19.7	17.5	14.8	17.6	17.2	16.8	20.2	28.1	31.4	25.0	19.5	19.8	
	8500	258	32.6	-0.6	-1.8%		8500	21.3	17.2	14.7	17.2	17.1	17.0	20.6	29.9	33.2	27.6	21.0	21.1	
	9000	254	34.4	-0.3	-1.0%		9000	22.6	17.9	15.7	16.5	16.4	16.3	20.3	31.7	34.7	28.7	22.0	23.2	
	9500	252	36.1	-1.3	-3.5%		9500	23.8	18.4	16.2	15.7	16.4	17.6	21.3	33.6	37.4	30.7	24.0	24.0	
10000	255	38.5	-0.1	-0.3%	10000	23.2	18.1	17.4	17.2	17.6	18.1	21.7	33.4	38.6	32.7	25.9	26.8			
10500	255	41.4	2.8	7.2%	10500	23.2	18.1	17.4	17.2	17.6	18.1	21.7	33.4	38.6	32.7	25.9	26.8			
11000	256	42.3	3.7	9.5%	11000	23.2	18.1	17.4	17.2	17.6	18.1	21.7	33.4	38.6	32.7	25.9	26.8			
11500	256	40.9	2.3	5.9%	11500	23.2	18.1	17.4	17.2	17.6	18.1	21.7	33.4	38.6	32.7	25.9	26.8			
				-103.2																
†Ground Level refers to LC-32 ground level wind measurement @ 3881.56 ft above WGS-84. This line should be compared to ground level wind measurements at LC-32 (6 ft AGL), not balloon data.																				
<div><div>Key for Comparison Table</div><div><div>Violate Limits</div><div>Meet Limits (<10% Margin)</div><div>Meet Limits (>10% Margin)</div></div></div> <div><div>Key for Flight Wind Limits Table</div><div><div>Violate Limits</div><div>Meet Limits</div></div></div>																				



Day of Launch Weather





T-1:15 hrs Balloon (1145Z)

26



Day of Launch Weather





Day of Launch Weather



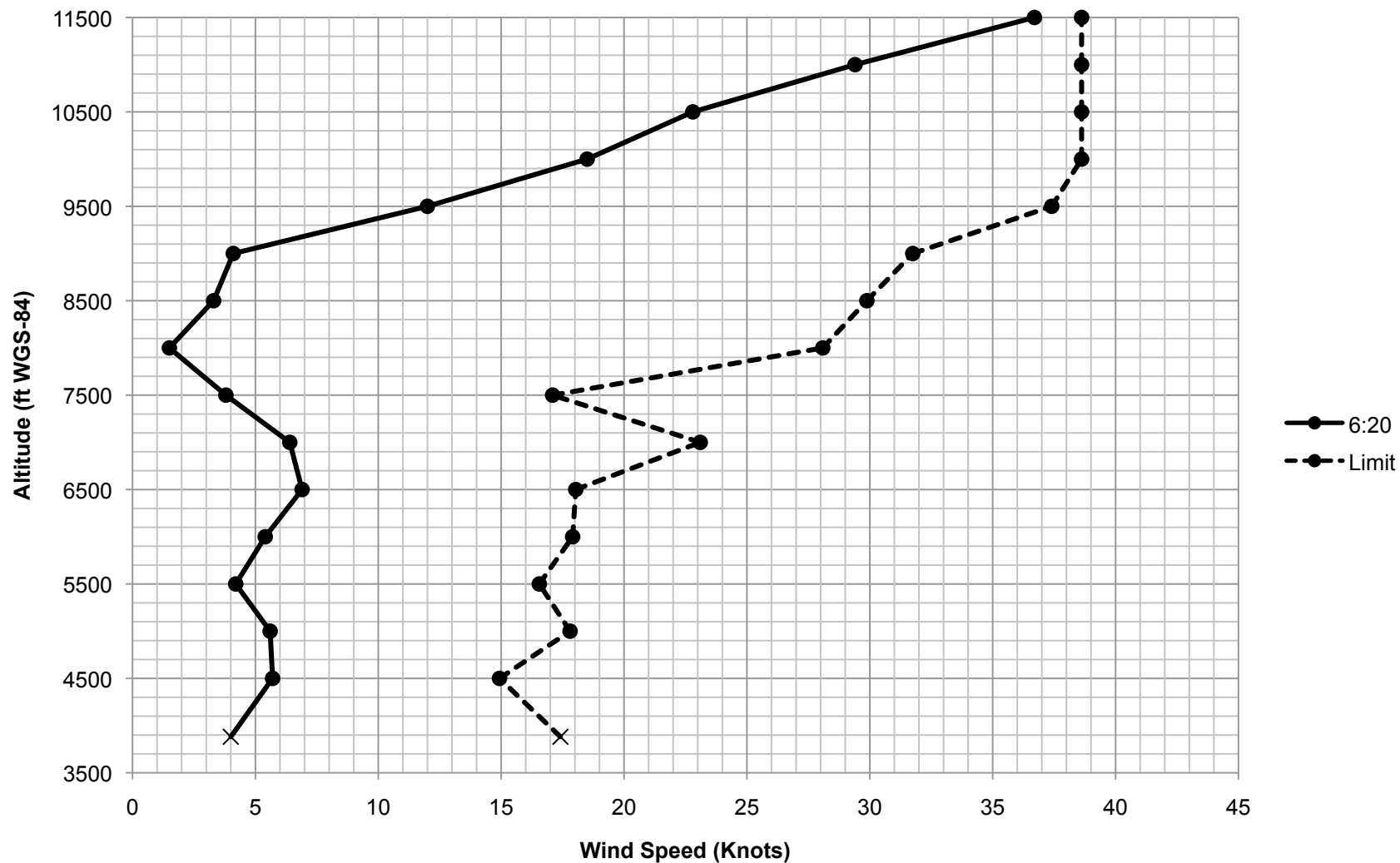
T-0:45 hrs Balloon (1215Z)

est

		Balloon Launch Local Time		6:20																
		Measured Winds		Comparison		Flight Wind Limits														
		Balloon & LC-32E Data Entry		Difference (Balloon - Limit)		Wind Speeds in Knots		Azimuth Clockwise from 0° North (degrees)												
								<u>Meteorological Convention</u> (Azimuth Defines Direction Wind is <u>Blowing From</u>)												
		Azimuth (Meterological degrees)	Wind Speed (knots)	(knots)	(percent)			1-30	31-60	61-90	91-120	121-150	151-180	181-210	211-240	241-270	271-300	301-330	331-360	
Altitude Above WGS-84 Ellipsoid (ft)	Ground Level*	90	4	-13.4	-77.0%	Altitude Above WGS-84 Ellipsoid (ft)	Ground Level*	17.0	19.0	17.4	14.8	11.6	13.3	16.4	24.2	23.9	16.3	13.6	13.3	
	4500	134	5.7	-9.2	-61.8%		4500	16.2	18.9	18.1	14.8	14.9	16.0	21.4	29.8	27.0	18.1	18.2	17.2	
	5000	127	5.6	-12.2	-68.5%		5000	20.2	21.6	18.2	17.2	17.8	18.4	25.8	30.5	34.2	20.7	20.0	19.2	
	5500	113	4.2	-12.4	-74.6%		5500	21.4	22.7	18.2	16.6	16.5	21.9	25.4	30.8	32.9	23.9	20.1	20.6	
	6000	101	5.4	-12.5	-69.8%		6000	20.8	23.8	20.5	17.9	18.4	18.5	26.5	33.3	36.2	28.3	21.4	23.3	
	6500	104	6.9	-11.1	-61.7%		6500	23.1	25.7	21.3	18.0	18.4	18.7	27.8	36.2	38.1	28.8	24.5	24.5	
	7000	78	6.4	-16.7	-72.3%		7000	24.6	26.1	23.1	18.1	17.6	17.1	27.1	35.2	41.6	35.0	24.6	27.7	
	7500	58	3.8	-13.3	-77.8%		7500	17.9	17.1	14.3	15.7	14.2	15.8	19.1	26.3	29.0	23.0	18.8	18.2	
	8000	229	1.5	-26.6	-94.7%		8000	19.7	17.5	14.8	17.6	17.2	16.8	20.2	28.1	31.4	25.0	19.5	19.8	
	8500	231	3.3	-26.6	-89.0%		8500	21.3	17.2	14.7	17.2	17.1	17.0	20.6	29.9	33.2	27.6	21.0	21.1	
	9000	235	4.1	-27.6	-87.1%		9000	22.6	17.9	15.7	16.5	16.4	16.3	20.3	31.7	34.7	28.7	22.0	23.2	
	9500	258	12	-25.4	-67.9%		9500	23.8	18.4	16.2	15.7	16.4	17.6	21.3	33.6	37.4	30.7	24.0	24.0	
	10000	259	18.5	-20.1	-52.1%		10000	23.2	18.1	17.4	17.2	17.6	18.1	21.7	33.4	38.6	32.7	25.9	26.8	
	10500	261	22.8	-15.8	-41.0%		10500	23.2	18.1	17.4	17.2	17.6	18.1	21.7	33.4	38.6	32.7	25.9	26.8	
11000	264	29.4	-9.2	-23.9%	11000	23.2	18.1	17.4	17.2	17.6	18.1	21.7	33.4	38.6	32.7	25.9	26.8			
11500	263	36.7	-1.9	-5.0%	11500	23.2	18.1	17.4	17.2	17.6	18.1	21.7	33.4	38.6	32.7	25.9	26.8			
				-254.1																
*Ground Level refers to LC-32 ground level wind measurement @ 3881.56 ft above WGS-84. This line should be compared to ground level wind measurements at LC-32 (6 ft AGL), not balloon data.																				
<div>Key for Comparison Table</div> <div>Violate Limits <div></div></div> <div>Meet Limits (<10% Margin) <div></div></div> <div>Meet Limits (>10% Margin) <div></div></div>																				
<div>Key for Flight Wind Limits Table</div> <div>Violate Limits <div></div></div> <div>Meet Limits <div></div></div>																				



Day of Launch Weather





Day of Launch Weather



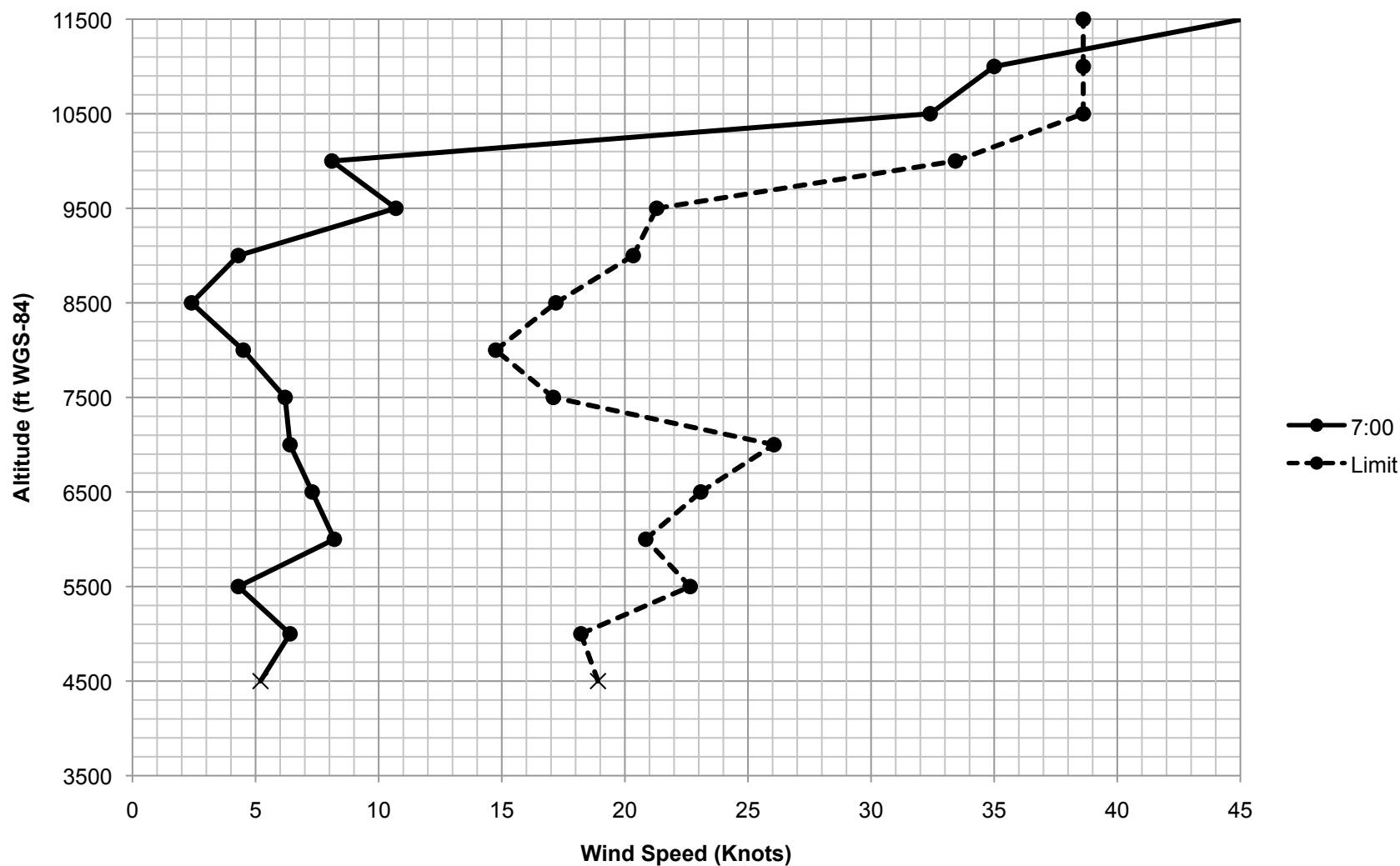
T-0:00 hrs Balloon (1300Z)

st

		Balloon Launch Local Time		7:00																																			
		Measured Winds		Comparison		Flight Wind Limits																																	
		Balloon & LC-32E Data Entry		Difference (Balloon - Limit)		Wind Speeds in Knots		Azimuth Clockwise from 0° North (degrees)																															
								<u>Meteorological Convention</u> (Azimuth Defines Direction Wind is <u>Blowing From</u>)																															
		Azimuth (Meterological degrees)	Wind Speed (knots)	(knots)	(percent)			1-30	31-60	61-90	91-120	121-150	151-180	181-210	211-240	241-270	271-300	301-330	331-360																				
Altitude Above WGS-84 Ellipsoid (ft)	Ground Level*			FALSE	FALSE	Altitude Above WGS-84 Ellipsoid (ft)	Ground Level*	17.0	19.0	17.4	14.8	11.6	13.3	16.4	24.2	23.9	16.3	13.6	13.3																				
	4500	44	5.2	-13.7	-72.5%		4500	16.2	18.9	18.1	14.8	14.9	16.0	21.4	29.8	27.0	18.1	18.2	17.2																				
	5000	66	6.4	-11.8	-64.9%		5000	20.2	21.6	18.2	17.2	17.8	18.4	25.8	30.5	34.2	20.7	20.0	19.2																				
	5500	56	4.3	-18.4	-81.0%		5500	21.4	22.7	18.2	16.6	16.5	21.9	25.4	30.8	32.9	23.9	20.1	20.6																				
	6000	24	8.2	-12.6	-60.7%		6000	20.8	23.8	20.5	17.9	18.4	18.5	26.5	33.3	36.2	28.3	21.4	23.3																				
	6500	22	7.3	-15.8	-68.4%		6500	23.1	25.7	21.3	18.0	18.4	18.7	27.8	36.2	38.1	28.8	24.5	24.5																				
	7000	39	6.4	-19.7	-75.4%		7000	24.6	26.1	23.1	18.1	17.6	17.1	27.1	35.2	41.6	35.0	24.6	27.7																				
	7500	59	6.2	-10.9	-63.7%		7500	17.9	17.1	14.3	15.7	14.2	15.8	19.1	26.3	29.0	23.0	18.8	18.2																				
	8000	78	4.5	-10.3	-69.5%		8000	19.7	17.5	14.8	17.6	17.2	16.8	20.2	28.1	31.4	25.0	19.5	19.8																				
	8500	105	2.4	-14.8	-86.0%		8500	21.3	17.2	14.7	17.2	17.1	17.0	20.6	29.9	33.2	27.6	21.0	21.1																				
	9000	182	4.3	-16.0	-78.9%		9000	22.6	17.9	15.7	16.5	16.4	16.3	20.3	31.7	34.7	28.7	22.0	23.2																				
	9500	198	10.7	-10.6	-49.7%		9500	23.8	18.4	16.2	15.7	16.4	17.6	21.3	33.6	37.4	30.7	24.0	24.0																				
10000	225	8.1	-25.3	-75.8%	10000	23.2	18.1	17.4	17.2	17.6	18.1	21.7	33.4	38.6	32.7	25.9	26.8																						
10500	242	32.4	-6.2	-16.1%	10500	23.2	18.1	17.4	17.2	17.6	18.1	21.7	33.4	38.6	32.7	25.9	26.8																						
11000	249	35	-3.6	-9.4%	11000	23.2	18.1	17.4	17.2	17.6	18.1	21.7	33.4	38.6	32.7	25.9	26.8																						
11500	253	45.1	6.5	16.8%	11500	23.2	18.1	17.4	17.2	17.6	18.1	21.7	33.4	38.6	32.7	25.9	26.8																						
				-183.2																																			
*Ground Level refers to LC-32 ground level wind measurement @ 3881.56 ft above WGS-84. This line should be compared to ground level wind measurements at LC-32 (6 ft AGL), not balloon data.																																							
Key for Comparison Table																				Key for Flight Wind Limits Table																			
Violate Limits																				Violate Limits																			
Meet Limits (<10% Margin)																				Meet Limits																			
Meet Limits (>10% Margin)																																							



Day of Launch Weather

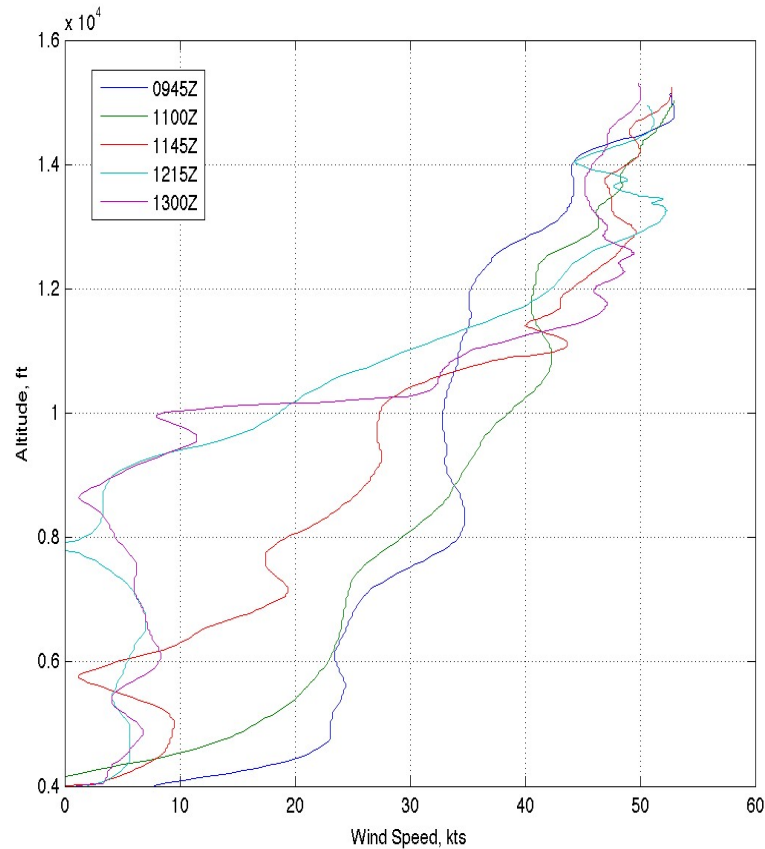




ANALYSIS

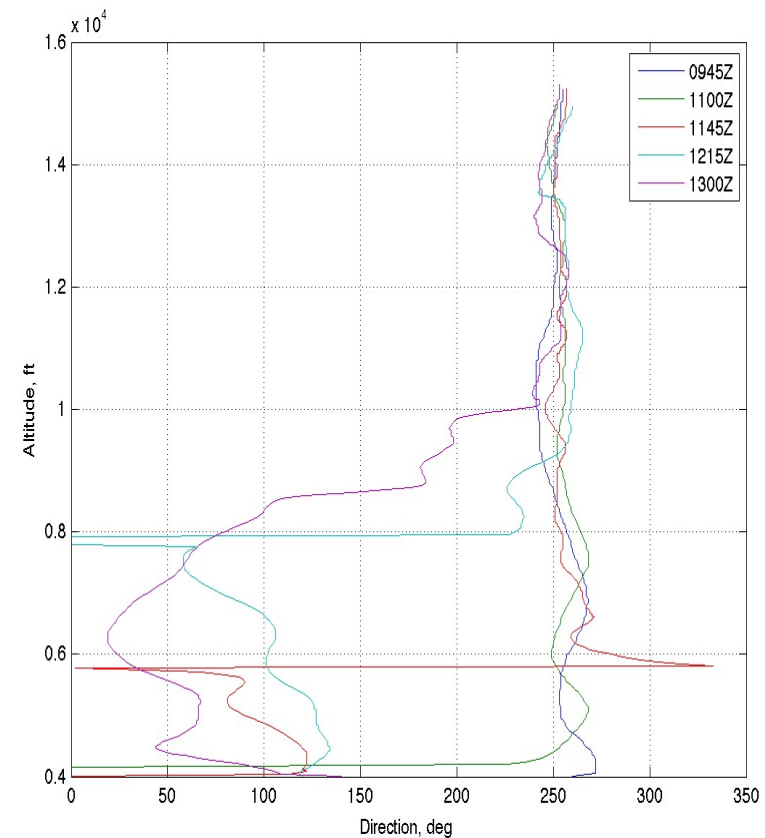


Weather Balloons Summary



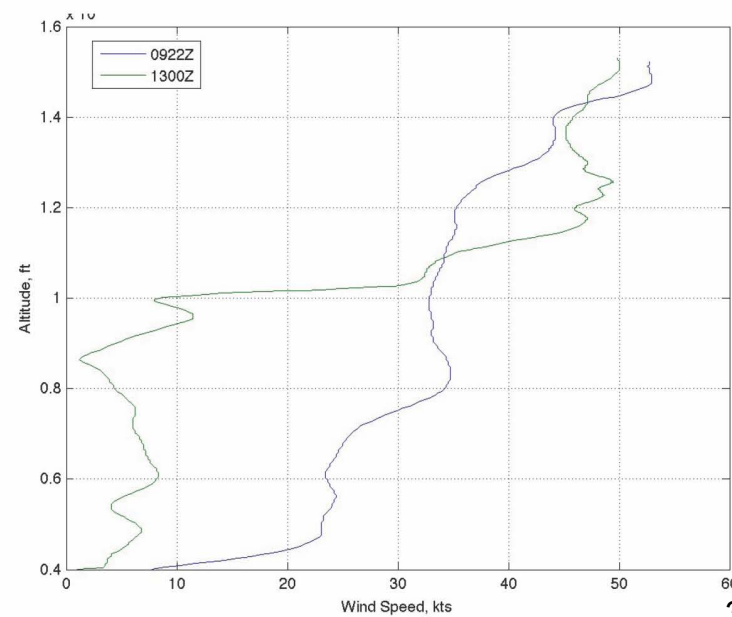
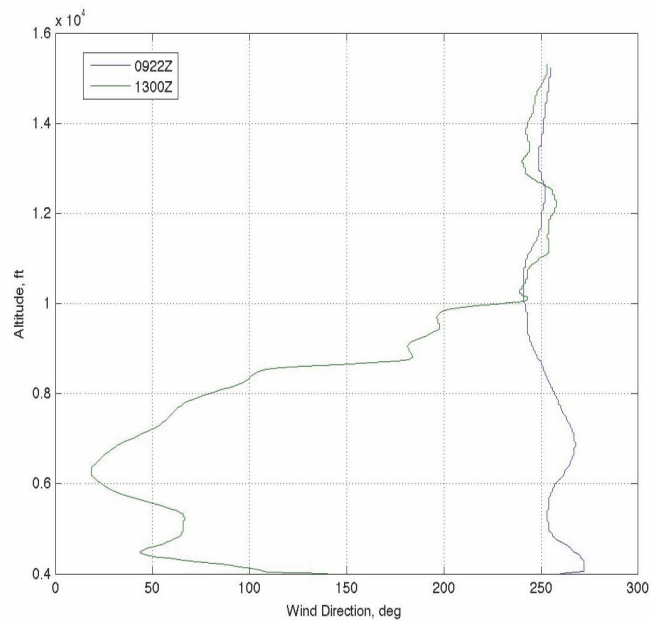
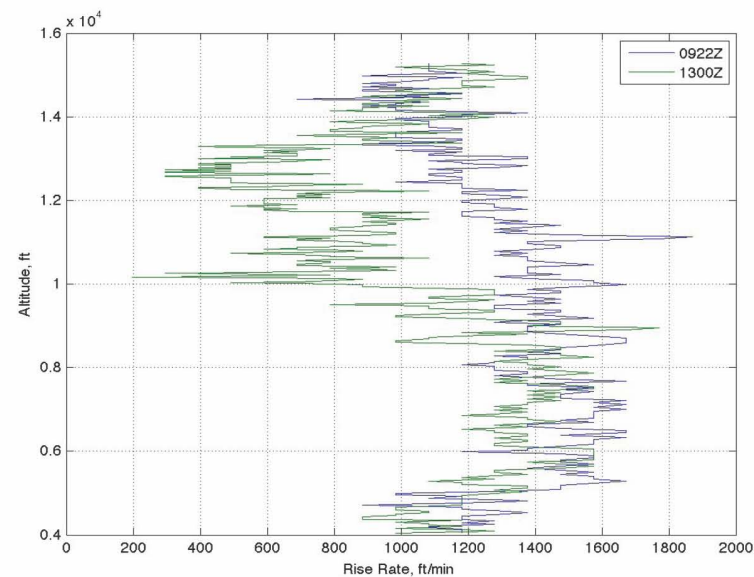
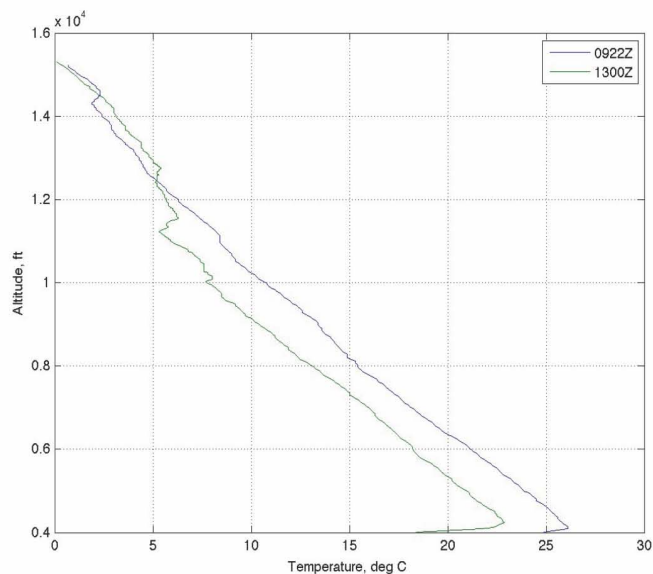
- Speed decreases w/time
- Speed change occurs below 10Kft

- Direction Agreement above 10kft



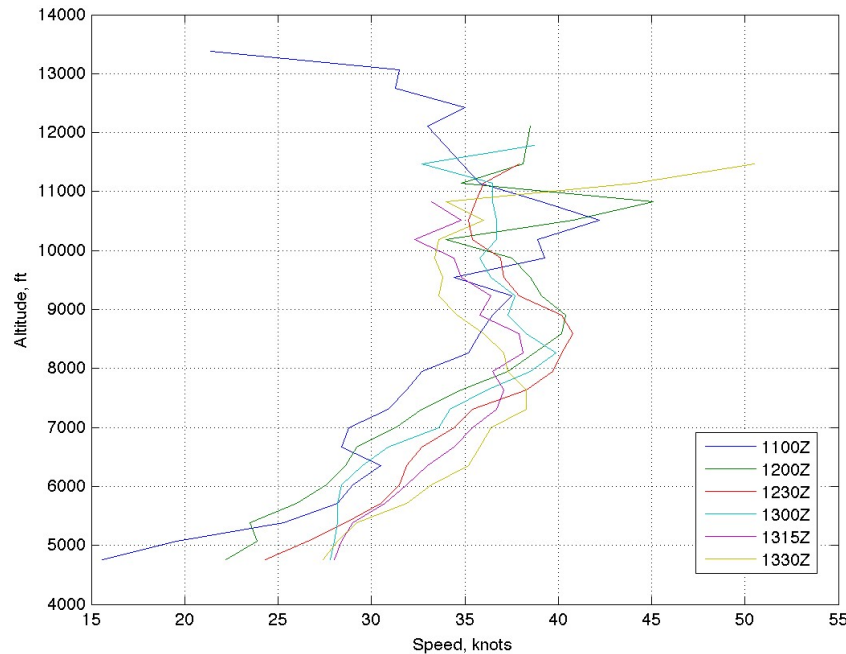


First and Last Balloon Comparison



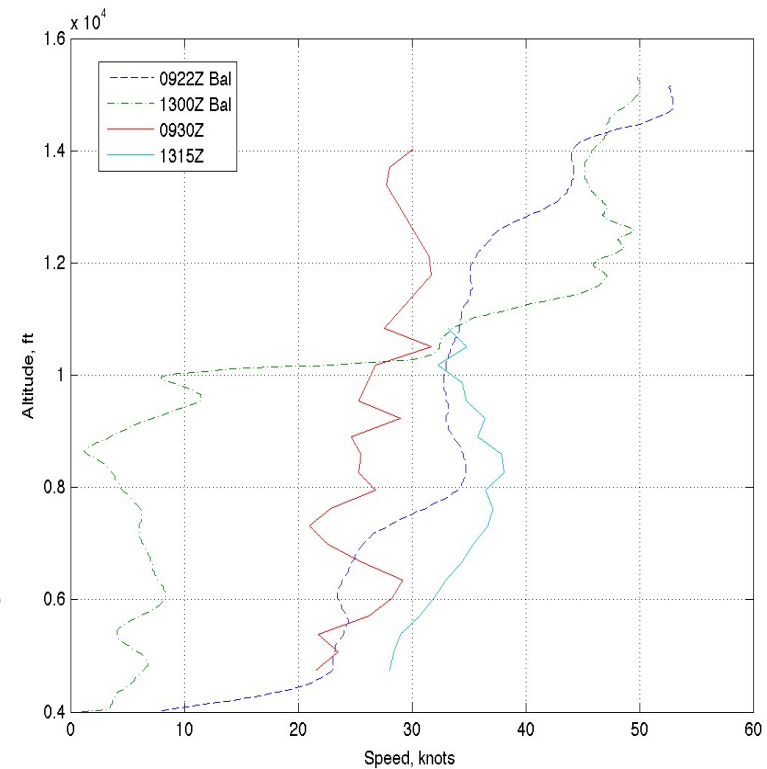


Balloon / Profiler Comparison



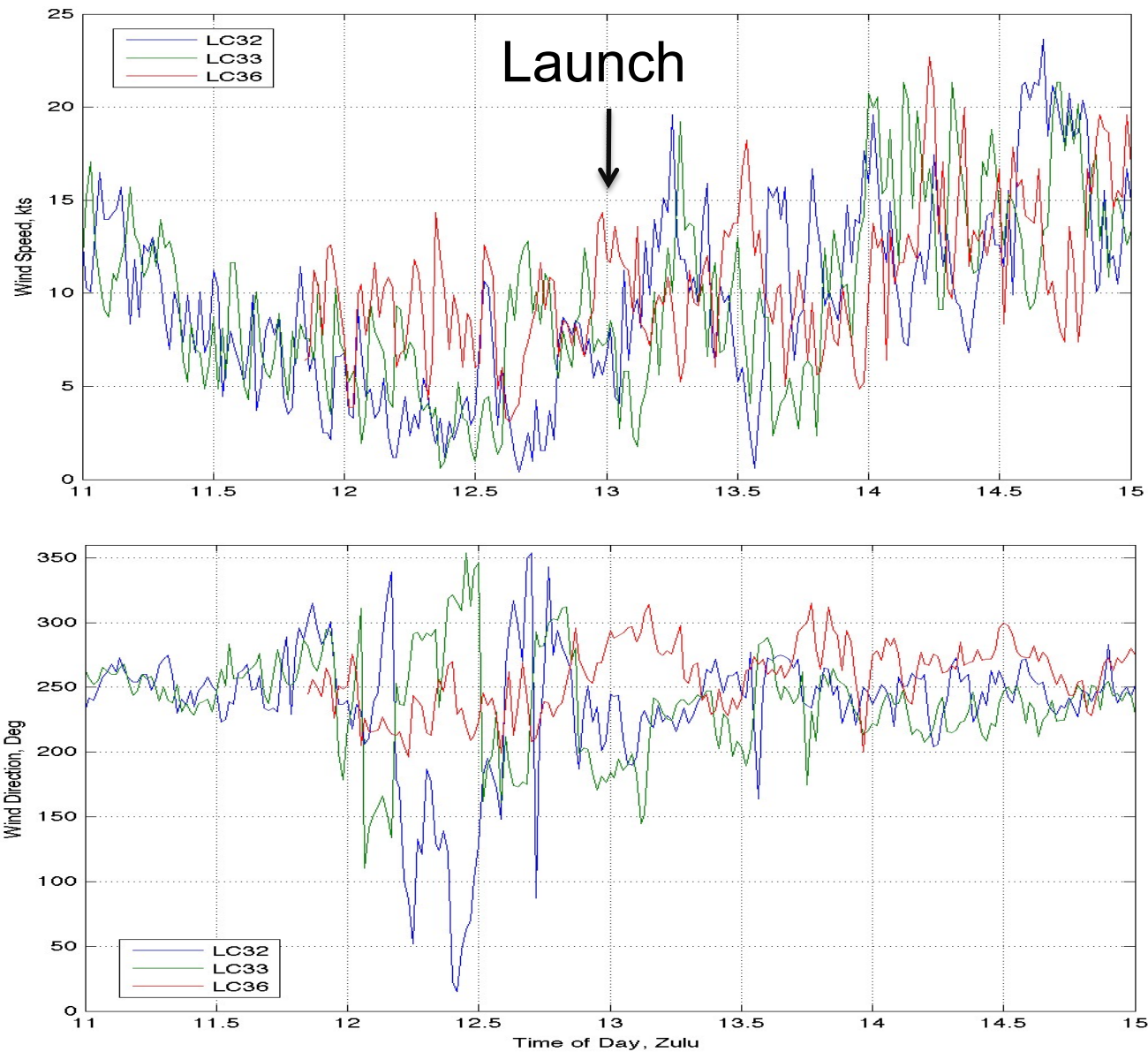
- Two and a half hours of profiler soundings near launch
- Speeds are constant over time

- First and last balloon w/Profiler comparison





Surface Wind (6ft) Behavior at Launch

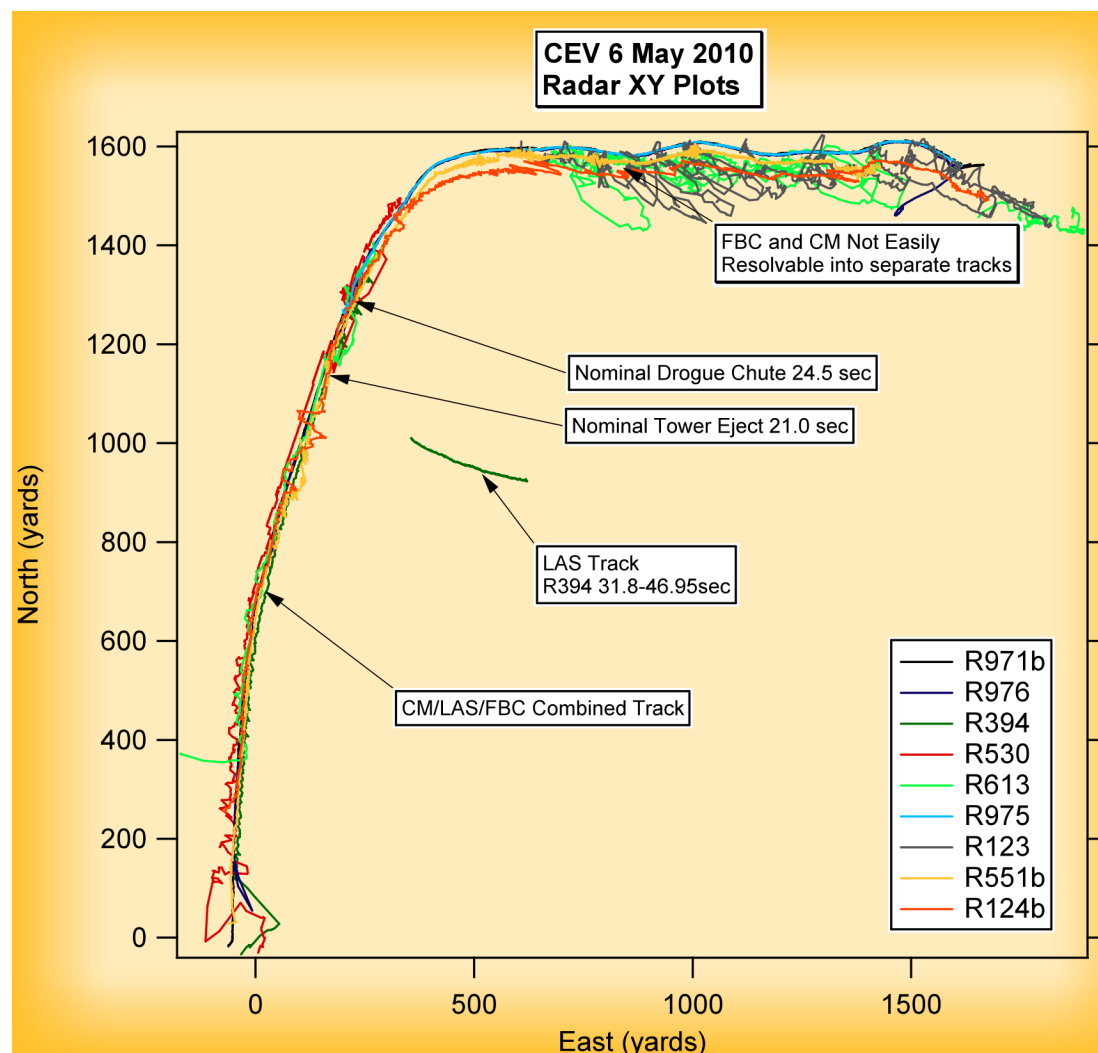




Radar Tracked Components



- Composite overlay of all of the valid radar tracks agree with profiler not balloon





Summary



- Upper level winds strong due to tightening gradients
- Terrain induced variability (block, deflect, waves...)
- Profiler should have been used in the go/no-go decision process
- Never enough sensors when terrain involve for re-analysis
- Mountain waves were in the vicinity and last balloon showed signs of being in a wave
- More time would be needed to really understand the events of the day---probably won't happen.